October 25, 2001

MEMORANDUM FOR: Clifton S. Middleton
Project Director, Survey Section B

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: COLORADO FBN, 2001 (GPS-1629)
Task Number: 8K6D2000

GENERAL:

The National Geodetic Survey (NGS), in accordance with the NGS Strategic Plan, is engaging in a campaign of observing stations of the Federal Base Network (FBN) to complete the ellipsoidal and orthometric height components of the FBN. This survey will observe 14 fill-in stations in Colorado while tying to approximately 20 recently observed crustal motion stations in the state and a total of approximately 7 stations in Utah and Wyoming.

The project coordinator is Mr. Richard Cohen, NGS State Geodetic Advisor for Colorado.

The Colorado Department of Transportation and various counties in the state may also co-observe and will have their observations coordinated by Mr. Cohen.

PURPOSE:

In order to meet America's accelerating positioning and navigation needs, the existing coordinate reference system must be continually enhanced to provide the accessibility and high accuracy required for use with GPS. The digital revolution in mapping, charting, and surveying requires a National Spatial Reference System (NSRS) consisting of, among other components, a network of monumented points having four-dimensional positions. The FBN fulfills the requirements for this component. NGS is charged with the Federal responsibility for establishment, observation, monitoring, and maintenance of the FBN. The FBN provides the critical network foundation for an accurate, consistent, reliable NSRS.

N/NGS21:DHendrickson:713-3194:amg:10-18-01
A:\CORO

The NSRS, in turn, provides the common geographic framework for America's spatial data infrastructure. As such, the NSRS serves as the basis for mapping, charting, navigation, boundary determination, property delineation, infrastructure development, resource evaluation surveys, and scientific applications, including crustal motion monitoring, modeling of flooding, storm surge, pollution trajectories, and agricultural runoff. A modernized, accurate, consistent, reliable NSRS is of enormous benefit to state, county, tribal, local, and Federal authorities, as well as to the private sector.

The project will be performed under the technical management of NGS.

SPECIFICATIONS:

Project requirements for the observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

Data from nine National CORS and one NGS Cooperative CORS in the region are to be used in the processing. Five of the National CORS are in Colorado; two are in Nebraska; and one each is in New Mexico and Wyoming. The Cooperative CORS is also in Colorado.

The five National CORS in Colorado are: Colorado Springs (AMC2), Table Mountain (TMGO), Platteville (PLTC), Boulder (DSRC), and Granada (GDAC). The two National CORS in Nebraska are Whitney (WHN1) and McCook (RWDN). Aztec (AZCN) and Medicine Bow (MBWW) are the National CORS in New Mexico and Wyoming, respectively. The NGS Cooperative CORS is MC01 and is located in Grand Junction.

Positions and data for the National and Cooperative CORS are available from the NGS web site.

General specifications for the project are as follows. At each fill-in station, three 5½ hour sessions are required. For the crustal motion and out-of-state tie stations, only one 5½ hour session is needed.

For stations that are being occupied with three 5½ hour sessions, the start time of one of the sessions must be staggered by at least 4 hours from the other two. In this

regard, two observing windows have been selected - 1400 UTC and 1800 UTC. Vectors between the project stations shall be measured by single sessions consisting of continuously and simultaneously tracking for 5½ hours.

The observing scheme shall be arranged to ensure that adjacent stations are directly connected in at least one observing session, and at least half of all base lines are repeated. The CORS base lines will be repeated. CORS data will be used throughout the project.

Each station, if not a first- or second-order bench mark, must be tied to two different bench marks. This bench mark tie requirement can be satisfied in one or two sessions.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations Handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey Data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, reprinted with corrections August 1, 1989. Specific project criteria and deviations from the general specifi-cations are given in the following sections.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

Record weather data just before, immediately after, and at the mid-point of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible.

Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey operations shall be conducted with due regard to the safety of personnel and equipment. Contact with the airport traffic control tower is mandatory during surveys at any controlled airports.

Vector Computations - Data management, quality review of collected data, and final vector processing for the survey will be accomplished using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use 30-second epoch intervals for data processing. Monument positions will be used for CORS when available, otherwise, antenna reference point (ARP) positions will be used. Mr. Rick Foote, N/NGS22, will be responsible for the processing.

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the CORS. The “fixed baseline” option in PAGES will be used to compute direct baselines between the CORS. The “fixed baseline” scheme will depend on the location and reliability of the CORS used in this project.

For stations where weather data are not available, or are suspect, predicted values computed in PAGES based on the station's latitude, height above mean sea level, and time and day of year will be used. Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible.

The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining the CORS will be performed.

The Observation and Analysis Division will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST. All B-files and G-files must be complete, including *25* and *27* records.

This project is to be combined with the recently completed Colorado crustal motion project and adjusted all together as one project.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using WDDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners. Richard Cohen will be responsible for the station descriptions.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers.

Fixed-height tripods shall be tested for stability, plumb alignment, and height verification at the start and end of the project. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed.

They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log.

Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, digital photographs of each survey mark are required. See “Requirements for Digital Photographs of Survey Marks & CORS Antennas,” Version 5, for specific information.

Also, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded on the GPS Station Observation Log form (available at http://www.ngs.noaa.gov/PROJECTS/FBN and click on the Forms link) at each occupation of a station:

(1) receiver manufacturer,
(2) antenna manufacturer,
(3) receiver model number (part number),
(4) antenna model number (part number),
(5) the complete serial number of the receiver, and
(6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Project Development Branch, N/NGS21, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Project Development Branch immediately.

The survey team shall not depart the project area until they have quality reviewed all data, advised N/NGS21, and notified N/NGS41.

GPS DATA:

Visibility tables and plots of the present satellite constellation for October 17, 2001, have been reviewed and two observing windows selected. For operational use, current data must be generated with Trimble mission planning software or from program SATMAP.

A project report and the data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" and in the attached addendum for the adjustment portion of the project must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Project Development Branch, N/NGS21. Richard Cohen is responsible for gathering the data and transmitting it to Rick Foote.

The data set collected during the project shall be named "coro101d.897". All records in connection with this project shall be titled “COLORADO FBN, 2001". The project number (accession number) is GPS-1629.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway
Silver Spring, Maryland 20910-3282

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer
Observation and Analysis Division
N/NGS4, SSMC III, Station 8562
Telephone: 301-713-3176, ext. 104
Fax: 301-713-4327
e-Mail: Maralyn.Vorhauer@noaa.gov

Questions and problems concerning vector processing should be directed to:

Rick Foote
Global Positioning Branch
Spatial Reference System Division
N/NGS22, SSMC III, Station 8824
Telephone: 301-713-3205 ext. 152
Fax: 301-713-4324
e-Mail: Rick.Foote@noaa.gov

Questions and problems concerning using CORS data in processing should be directed to:

Neil Weston
Geosciences Research Division
N/NGS6, SSMC III, Station 9830
Telephone: 301-713-2847, ext. 202
Fax: 301-713-4475
e-Mail: Neil.Weston@noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)
Chief, Project Development Branch
Spatial Reference System Division
N/NGS21, SSMC III, Station 8853
Telephone: 301-713-3194, ext. 111 (ext. 127)
Fax: 301-713-4316
e-Mail: Steve.Frakes@noaa.gov
(Doug.Hendrickson@noaa.gov)

The coordinator for the project is the NGS State Geodetic Advisor for Colorado:

Richard Cohen, NOAA RC
325 Broadway
Boulder, Colorado 80303
Telephone: 303-758-9197
e-Mail: fossilgps@aol.com

Names and telephone numbers of local contacts are given in the station description material.

ADDRESS:

Keep N/NGS41 informed of the party's physical address and telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

Expenses for this project will be charged to task number 8K6D2000.

TRAVEL:

Travel and per diem are authorized in accordance with Federal Travel Regulations, Part 301-11, Per Diem Allowances. Current per diem rates were effective October 1, 2001.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski*
N/NGS - S. Misenheimer*
N/NGS1 - G. Mitchell
N/NGS1x1 - R. Cohen
N/NGS11 - S. Cofer
N/NGS21 - S. Frakes
N/NGS21 - R. Anderson
N/NGS21 - D. Hendrickson*
N/NGS22 - T. Soler
N/NGS22 - R. Foote
N/NGS3 - J. Bailey
N/NGS4 - E. Wade
N/NGS4 - M. Vorhauer
N/NGS4 - D. Hoar
N/NGS41 - W. McLemore
N/NGS5 - R. Snay
N/NGS6 - N. Weston
FGCS Members*
Fred Blume, University of Colorado

* first page only

DATA TO BE SENT TO HEADQUARTERS RELATING TO THE ADJUSTMENT PORTION OF FBN/CBN PROJECTS

Free adjustment in NAD 83 (UNIX run).

Plots of the free adjustment created by running "plotres_prompt.bsh" on a UNIX server. Plots require a printer that supports postscript. The output file (long.out) contains a list of residuals which may be sorted using the following commands:

```
vi long.out
:1,$ !sort +0.47 (sorts horizontal residuals)
:1,$ !sort +0.71 (sorts vertical residuals)
```

(OPTIONAL) Constrained horizontal adjustment holding NGS CORS positions and ellipsoid heights.

Final combined Blue Book file (ASCII required) with *86* records (GEOID99).

Final description file (ASCII required.)

Final G-file (ASCII required.)

OBSCHK output.*

CHKDDESC output.*

OBSDES output.*

*Any errors or warning messages must be explained.